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THE NATURE OF A SPECIES IN PALEONTOLOGY, AND A NEW KIND OF TYPE SPECIMEN

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In discussing the subject, "What is a species?" with my associates in vertebrate paleontology, many points of interest have come up which will bear repeating. The great complexity of the problem and the number of elements which enter into its composition make the solution difficult—perhaps impossible—for certainly no single definition can apply in every case.

Professor Schuchert has said that he finds it best to let the man who is studying a given specimen decide what a species is, after he has read several definitions, and that even for students who are writing their first papers it is best left to the individual; he may stand or fall on his ingenuity in handling this unanswerable question.

The more deeply we go into the study of a specimen, not only do the features multiply, but they increase in importance, and thus we raise a variety to a species, or a species to a genus. Along with the personal element and the extent of our knowledge, very important factors indeed, we must in paleontology consider another, viz., the actual worth of the specimen, and it is undeniable that a new species should not be made on fragmentary material unless its characters are unique and of such importance as to reveal the existence of a new and strange group of animals, hence scarcely less than a genus or even a family. As an example of such specimens, whose discovery gave us the first knowledge of strange groups, there may be mentioned *Archaeotherium mortoni* Leidy, *Ammodon leidyanus* Marsh, or *Rhinoceros occidentalis* Leidy.

It is a well-known fact, and yet one not fully recognized, that new types based on good specimens are and should be made, to supplant older inadequate ones. We may cite as an example the mammal *Dinohyus* Peterson, which Matthew says is not different from *Daeodon* (*D. shoshonensis* Cope), or the dinosaur *Tyrannosaurus,* which may be identical with *Manospondylus* (*M. gigas* Cope). Many such examples might be given showing where a more complete skeleton has usurped the taxonomic position of a type based on a mere fragment, thereby forcing the latter to fall into a group of historic relics, which merely mark the progress of our science.

A new kind of type specimen.—It is here suggested that we recognize this principle of substitution as a useful one, and we propose the name of *protype* (=for the proterotype) for such a supplanting type specimen. A protype should be based only on a very complete skull or skeleton. It is based on supplementary material, and as such is one of the forms of apotypes. In other words, a protype may be said to be a proxy, for it operates with full authority under a special designation. The material of a protype should, it would seem, be given a new name, preferably as a subspecies, for in such a humble position under the original proterotype it preserves the name of the older species replaced; it has the taxonomic advantage of linking the two together, and furthermore, if it is later found that the new specimen is not identical with the older, the subspecies can be raised to the full rank of a species.

Thus it is evident that a new species name should only be given, first, in the case of a protype, as just set forth, and second, to any specimen, fragmentary or perfect, which clearly possesses distinguishing features or some unusual or unique morphologic character that may be accentuated by its stratigraphic occurrence and that needs to be published and made widely known, thereby adding to the sum total of human knowledge.

Making of species.—Many naturalists have ventured an opinion as to what limit of variation should constitute the bounds of a species. This has, by common consent, been determined by the limits of interbreeding, where procreation is impossible or the offspring is sterile. In the natural state, it is interesting to note that, though the barrier is usually a physical or physiological one, yet it may be purely psychological, and as such may break down in captivity, giving rise to most unusual hybrids capable of reproducing their kind.

There exist the so-called geographical species which show no marked morphologic differences. Modern biologists make such distinctions in color or in the nature of the hair or muscles; these are, however, criteria necessarily lost to the paleontologist, who generally has only the hard parts for study. The student of vertebrate fossils is further limited, as a rule, in his making of species, to a single specimen, while the student of modern biology has many cotypes or paratypes.

Considering the vastness of geological time, it is easy to see that two specimens of the same geological formation may have been separated by tens of thousands of years, during which important changes not only of habitat but as well of form and habits may have occurred. In such a case, nothing of the resulting trivial changes in the soft parts may be discerned.

Relativity of species.—Generally the small unit characters have value only when grouped; not always does a specific feature fully determine the bounds of a species. But on the other hand, no matter how trivial this character may appear to be, if we find it occurring constantly in one set of specimens and not in others, it is to be regarded as specific in value and typifies the individuals of that group. Furthermore, not all the varieties referred to a species may have all of the so-called specific characters. Two specimens under the same species may have but one or two only of the several secondary features supposed to characterize the group as a whole.

Distinguishing characters are of two classes, relative and absolute. Sometimes a relative difference may be advanced so far that it appears to be, or may actually become, absolute; for example, the growth of a bone until it meets a joint and develops a facet, or the reduction of a premolar to a point where it becomes obsolete. The so-called absolute characters may be thought of as unit characters. Relative characters may be illustrated by the familiar variation in size, and then we wonder what the limits of size are beyond which animals cannot interbreed, for we realize how positive a barrier this may become. In this respect it seems safe to say that in mammals a size difference of 30 per cent would tend to separate two groups, based on our general conception of the ultimate barrier between species.

Carrying the subject to a further quantitative analysis, what range of "ratios" can we allow within a species? Two skulls of approximately the same size may vary in proportions, one part being 15 per cent larger, another part as much smaller. Here is a range of 30 per cent; is it a specific difference? The personal equation of course enters into all such questions and the resulting taxonomy.

Presenting specific characters.—A glance through the literature shows many instances where an author at the beginning of an original description states that the "specific characters" are so and so, and proceeds to list a number of features which, taken singly, might not even be subspecific, or, on the other hand, might be generic. In addition, these "specific characters" which may serve to distinguish two species do not show a contrast with a third or fourth; for instance, characters "a" may show the distinction from species "A," but we must look for another group of criteria, "b," to separate our species from "B." A species depends not only upon its own features as selected by its author, but upon the features of the other species in the genus as well; the specific characters marking the boundary in one direction may not be such as to show it in another.

New discoveries are constantly being made which contradict general statements of distinctions, and overturn our nicely adjusted taxonomy, unless we carefully indicate the type material compared when we draw our contrasts. The safer course, then, seems to be to limit one's self to the "distinguishing characters," as so many paleontologists do, without making a guess as to what the undiscovered or unknown specimens may show; or to indicate just what species are being distinguished by certain characters, in which case the description resolves itself into as many parts as there are species to be compared, and each description shows definite contrasts and possibly a wholly different set of distinguishing features; all of this is again subject to one's learning and powers of contrasting the variables.

Summary.—In the last analysis it rests with each author what his specific differentiations will be, and their validity will often depend upon and be rated by the general standard of his work.

It is proposed here that, in accordance with a recognized need, we employ *protypes* to serve as "proxy types" to substitute for inadequate existing type material.

The practice is criticized of attempting to classify the characters of a type specimen as specific or generic without knowing all the related forms or without specifying the relation to each neighboring species or genus. It is suggested that contrasts be drawn with each other species separately, or that the noncommittal term "distinctive features" be used.